



WILLIAM JESSOP & SONS<sup>LD</sup>

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WILLIAM JESSOP & SONS, INC.

# JESSOP'S GENUINE SHEFFIELD STEELS

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MANUFACTURED IN  
SHEFFIELD, ENGLAND  
SINCE 1774

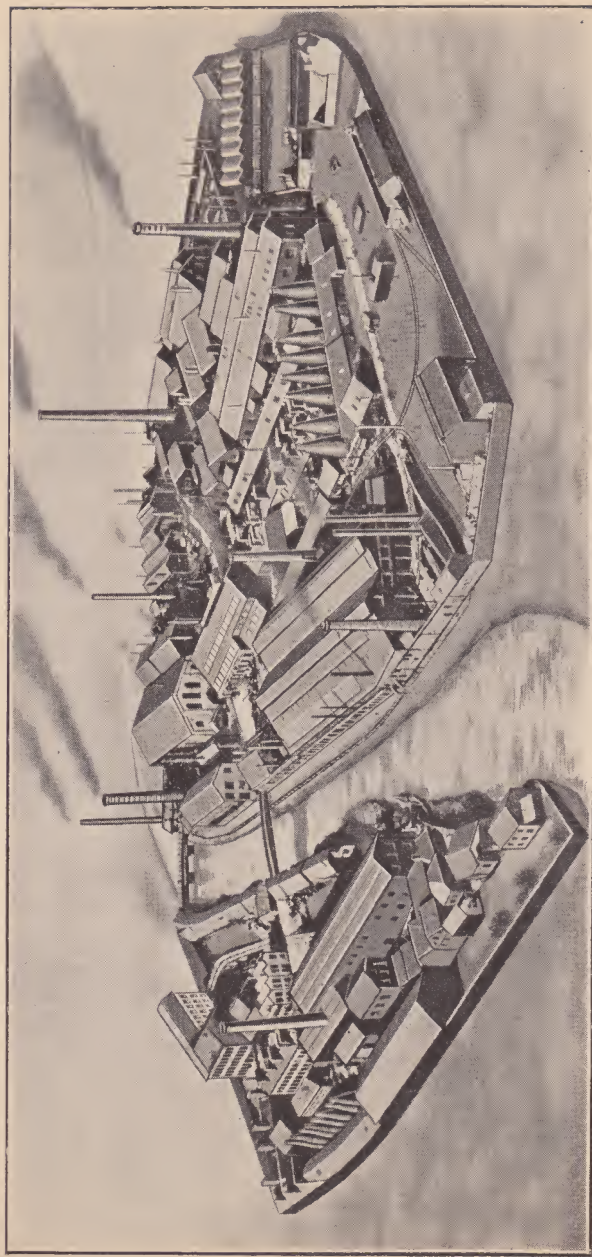
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## William Jessop & Sons, Inc.

91 JOHN STREET . . . .	NEW YORK
163 HIGH STREET . . .	BOSTON, MASS.
1857 FULTON STREET . .	CHICAGO, ILL.

ESTABLISHED 1774

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BRIGHTSIDE WORKS  
WILLIAM JESSOP & SONS, LTD., SHEFFIELD, ENGLAND





IN 1774, shortly after the crucible method of making steel had been introduced by Huntsman, William Jessop established a small Works in Sheffield, England, with the object of developing the manufacture of crucible steel. He had an ideal in mind—that of producing a better grade of steel than any other on the market at that time. His methods were much the same as those of other makers, but the quality of his products were improved by the exercise of exceptional care and skill in the selection of raw materials and in the various manufacturing operations.

This superior quality was soon recognized by the engineering world, and with a view to enlarging the market William Jessop decided to place his products on the American market in 1828, and to-day it can truthfully be claimed that many important American engineering industries owe their origin to the superior qualities of the crucible steels made by William Jessop in Sheffield.

Such a reputation acquired after patient and persistent efforts to maintain and improve the original high standard set by the founder, has been carefully safeguarded. As the science of engineering progressed, demanding both better grading of existing steels and new grades to meet more exacting conditions, William Jessop & Sons, Ltd., improved and perfected their plant by introducing new and refined methods of manufacture to meet modern conditions.

In addition they have organized and maintained a staff of highly trained and competent metallurgists and chemists constantly engaged on practical research work. Many special alloy steels have been evolved with a view to adaptability to particular purposes.

The basis of all high grade tool steels is Swedish bar iron and the finest available material in the world for this purpose are the Danne-mora brands. In this connection it is interesting to note that for many years Wm. Jessop & Sons, Ltd., have been the sole importers of the best brand of Dannemora Iron, namely, the double bullet—oo—brand.

## JESSOP'S GENUINE SHEFFIELD STEELS

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The same care has always been exercised in melting and other processes of manufacture, and new methods have been introduced only after careful examination by the technical staff, and proof that they will in no way deteriorate the high quality of the steels.

These steels are now universally recognized as standards of high quality. They are perfectly graded and guaranteed to wear well and give satisfactory service under the most exacting conditions.

William Jessop & Sons, Ltd., have had a unique experience in steel making in that it has extended continuously over 150 years, a tribute not only to the excellence of its products, but also to its integrity in business methods.

The services of our scientific and technical staff are available at any time for clients who require information, advice or assistance concerning their steel problems, and if necessary we will make experiments in any process of manufacture when necessary to the solution of particular problems.



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JESSOP'S GENUINE SHEFFIELD STEELS

***TERMS AND CONDITIONS OF SALE***

Terms are net cash within 30 days from receipt of invoice unless otherwise agreed in writing.

Prices and quotations are f.o.b. at our New York, Boston, Chicago or Toronto Warehouses.

Quotations are for immediate acceptance, and prices are subject to modification without notice.

Sales and contracts are contingent upon strikes, lock-outs, fires, serious accidents and other causes beyond our control.

Steel which is found to be defective when properly used will be replaced free of charge or credited, but no claims for labor or consequential damages can be allowed.

## Hints on Ordering Carbon Tool Steels

In order to get the best results out of a set of tools, it is desirable to take every precaution in making out the order so that suitable material of the correct shape and size is procured. To assist in this, the following hints have been compiled, more especially for the benefit of those steel users who do not possess the benefit of a staff of metallurgical experts to give advice on this important matter. When such advice is available it is customary for the user to specify the chemical analysis of the material required.

It should be distinctly understood that two factors, namely, grade and temper, are essential to the proper definition of a Carbon Tool Steel.

Grade has reference to the quality of the steel, and is a function of the raw materials used and the method of melting employed, while temper refers to the carbon content. The advantages of using a steel of high grade lies in the lessened degree of risk involved, principally during the hardening operations. In the production of intricate tools involving a high ratio of labor to material cost, it is folly to select anything but the highest grade of steel for the purpose; lower grade steels should be chosen only in cases in which there are to be made relatively simple tools, or tools which are to be used for very short runs.

Whenever possible, the carbon content required should be stated clearly. Since very early times it has been the custom of steel makers to decrease the carbon content with increasing size of bar. Originally, no doubt, this was intended to counteract the increased tendency of large bars towards cracking in the quenching operation. For the self-same reason squares, flats, octagons and hexagons usually possess a lower carbon content than round bars of equal sectional area. But with increased knowledge and improved methods of heat treatment, there should no longer be any necessity for this practice, and the carbon content of the bars should be determined entirely by the work which the finished tool has to do.

Another important factor to bear in mind is the inevitable surface decarburization which takes place during the forging and rolling of Tool Steel. This decarburization takes place principally during the early stages of working the steel when the mass is large enough to entail prolonged exposure to the furnace atmosphere. Subsequent working naturally reduces the thickness of the decarburized skin. Conse-



quently the machining allowance should be greater on large bars than on smaller ones. In this connection the following table will be a useful guide:

DIMENSIONS OF BARS	MINIMUM MACHINING ALLOWANCE
Below $\frac{1}{2}$ "	$\frac{1}{32}$ "
$\frac{1}{2}$ to 2"	$\frac{1}{16}$ "
2" to 4"	$\frac{1}{8}$ "
Over 4"	$\frac{3}{16}$ "

The machining allowance represents the material which must be removed in order to get below the decarburized layer.

In order to give further assistance in the proper selection of a steel for a particular purpose, the following table has been compiled, showing the temper numbers, approximate carbon contents and appropriate uses of Jessop's Sheffield Tool Steels. This table applies to our Yellow, Green and Black Label qualities indiscriminately.

TEMPER NO.	CARBON CONTENT	APPROPRIATE USE
7 8	0.70 - 0.85%	Smith's tools, pneumatic hammers and chisels, hollow punches, press tools, rivet snaps, die blocks, coal cutters, caulking tools, drifts, rock drills.
9	0.90 - 1.00%	Gauges, cold chisels and wood working tools; reamers, screw dies, press tools, drills, heavy punches, milling cutters, mandrels, shear blades, stone cutting tools, stamping tools and trimming dies.
10	1.00 - 1.10%	Large drills, pneumatic tools, punches and press tools, boiler tube expanders, broachers, cutting tools from 1" to 3" diameter, circular cutters up to $\frac{1}{2}$ " thick, collets and gauges up to 2" diameter, drills up to 2" diameter, end tools from $\frac{1}{2}$ " to $1\frac{1}{2}$ " diameter, gauges, grinding machine spindles, lathe centres, milling cutters, mandrels, mill picks, pipe cutters, jigs, snap gauges, straight edges, screw gauges, reamers and taps.
11	1.10 - 1.20%	Smaller drills, turning tools from $\frac{3}{4}$ " to about $1\frac{1}{2}$ " square, broaches, cutting tools from $\frac{3}{4}$ " to 1" square, drills up to $\frac{7}{8}$ " diameter, dies, file cutters, chisels, gauges, graver tools, heading dies, lathe centres, mandrels, recessing tools, screw dies, scrapers, templates, planing tools and small taps.
12	1.20 - 1.40%	Very small tools, engraving tools and rifling tools, broaches up to $\frac{3}{8}$ ", cutting tools up to $\frac{1}{2}$ " diameter, drills under $\frac{1}{2}$ ", fustian knives, feathers, gauges, screw gauges, planing tools.

## CARBON TOOL STEELS

### WM. JESSOP & SONS' CAST STEEL, WARRANTED.

#### BEST CAST STEEL — YELLOW LABEL

**T**HIS Steel needs no introduction to the American manufacturers, since it has been in continuous use since the early part of the last century. All that is best in carbon tool steels is summed up in Yellow Label, which is referred to as a standard by other steel-makers.

The Tool-Maker who is called upon to make tools, dies, etc., in which freedom from risk in hardening and long life are required, cannot afford to be without it.

**Annealing:** Heat to 1380° F. for 30 minutes to 12 hours, according to size of tool and results required, and allow to cool slowly.

**Forging:** Heat to 1575° F. for the lower tempers and 1500° F. for the highest temper. Do not continue hammering below 1100° F.

**Hardening:** Heat slowly to 1400 to 1450° F., according to temper; soak for appropriate time and quench in water or brine. Temper all tools at 400° F. to 550° F. for at least 20 minutes immediately after quenching.

Read carefully notes on treatment, Page 11

## CARBON TOOL STEELS

GREEN LABEL

William Jessop & Sons' Crucible Cast Steel

GREEN LABEL

### GREEN LABEL CAST STEEL

**O**N the grounds of production economy, modern engineering practice demands steels which are not necessarily of the same ultra quality as Yellow Label Steel.

Necessity demands that certain tools must be produced at a price which prohibits the use of the most expensive steels. In other cases the stresses to which a particular tool is subjected in use does not require the application of a steel of the highest quality. It is in these cases that this grade of steel is to be recommended with confidence, because it is made by the same methods and the same experienced craftsmen who are engaged in the production of Yellow Label Steel.

**Annealing:** Heat to 1380° F. for 30 minutes to 12 hours, according to size of tool and results required, and allow to cool slowly.

**Forging:** Heat to 1575° F. for the lower tempers and 1500° F. for the highest temper. Do not continue hammering below 1100° F.

**Hardening:** Heat slowly to 1400 to 1450° F., according to temper; soak for appropriate time and quench in water or brine. Temper all tools at 400° F. to 550° F. for at least 20 minutes immediately after quenching.

Read carefully notes on treatment, Page 11

## CARBON TOOL STEELS

BLACK LABEL

WILLIAM JESSOP & SONS' CAST STEEL

BLACK LABEL

### BLACK LABEL CAST STEEL

**M**ANY requirements demand a grade of tool steel of a comparatively low price, and the increasing demand for such a steel has prompted the introduction of this Brand to users. It is available in the same range of carbons as the two higher grade steels, and therefore its field of utility is very extensive. It is a steel suitable more particularly for those tools which are subjected to rough treatment during use.

**Annealing:** Heat to 1380° F. for 30 minutes to 12 hours, according to size of tool and results required, and allow to cool slowly.

**Forging:** Heat to 1575° F. for the lower tempers and 1500° F. for the highest temper. Do not continue hammering below 1100° F.

**Hardening:** Heat slowly to 1400 to 1450° F., according to temper; soak for appropriate time and quench in water or brine. Temper all tools at 400° F. to 550° F. for at least 20 minutes immediately after quenching.

Read carefully notes on treatment, Page 11



## Suggestions for the Treatment of Carbon Tool Steels

Since the difference between the various grades of our Carbon Tool Steels lies in the quality and not the content of those elements which go to determine the hardening of the Steel, the same forging, annealing and hardening instructions are applicable to all our grades of Carbon Steels.

FORGING should be carried out at 1500° to 1575° F., *i.e.*, bright to cherry red according to the temper of the steel. Great care should be taken to heat up the steel slowly, especially with the higher tempers, as these are very liable to acquire surface cracks by sudden heating. Forging should not be continued below 1100° F. or a blood red, otherwise the material is liable to be unduly stressed or even permanently damaged, both by external and internal cracking, which may or may not become apparent until after the final operation of hardening. It is better to reheat several times than to run the risk of over-heating or over-working brought about by operating outside the temperature range of 1100° F. to 1575° F. Another very important precaution is to leave ample allowances for machining on all surfaces which are to be hard.

ANNEALING may be carried out for a number of objects, the principal of which are:

1. The release of stresses set up by the preliminary operations, so as to prevent their affecting the subsequent ones.
2. To get the material into the proper condition for rapid and easy machining.

The first object can be attained by heating the forgings, blanks or roughly machined tools to 1380° F. very slowly, maintaining them at this temperature for 30 minutes after they are thoroughly soaked through, and then allowing them to cool slowly, preferably in the furnace. During the whole of this operation the furnace atmosphere should be kept non-oxidising, so as to prevent undue scaling and decarburisation of the pieces.



In order to get the material into the best condition for rapid and easy machining, a much longer operation is necessary. The tools should be closely packed into a box with a close-fitting lid, so as to exclude free access of air. This operation can be assisted by introducing charcoal or cast iron borings into the spaces between the tools. The box is then introduced into a furnace, the temperature raised to  $1380^{\circ}$  F. and maintained at this temperature for 4 to 12 hours, according to the degree of softness required, after which the box is allowed to cool down in the furnace over night.

**HARDENING** Heat the tools slowly to  $1400^{\circ}$  to  $1450^{\circ}$  F. and allow to soak at this temperature for 15 minutes to 1 hour, according to the mass of the tool. Remove from the furnace and quench in water or brine at  $75^{\circ}$  to  $80^{\circ}$  F. After the tools are quenched they should be removed immediately to the tempering bath.

**TEMPERING** should be performed on every tool, for even boiling in water has a great effect on the removal of internal stress. The actual tempering temperature should be from  $400^{\circ}$  F. to  $550^{\circ}$  F., according to the nature of the tool, and all tempering operations should be carried on for at least 20 minutes.



## Tempering Colors and Temperature used in Drawing Carbon Steels

In some cases a proper tempering bath is not available, and with certain classes of tools complete immersion is undesirable. A portion of the tool can then be polished bright with a piece of emery cloth and the tool placed on a hot plate and the temperature judged from the temper colors which appear on the polished surface. The following table shows the temperatures at which the various colors appear:

TEMPER COLOR	TEMPERATURE °F.
Light Straw .....	420°
Straw (Canary) .....	440°
Deep Straw .....	460°
Brownish Yellow .....	480°
Light Brown .....	500°
Dark Brown .....	520°
Purple .....	540°
Bluish Purple .....	560°
Blue .....	580°
Dark Blue .....	600°

In applying this method of tempering it is important always to keep the conditions the same, more particularly with regard to the rate of heating.

## NON-SHRINKABLE TOOL STEEL

### JESSOP'S SUPERIOR OIL-HARDENING STEEL

#### SUPERIOR OIL-HARDENING STEEL

**T**HIS Steel has been developed to meet the demand for a steel with a low coefficient of expansion and a small volume change through the critical range for the production of precision tools, such as taps, dies, master gauges. Makers of these classes of tools require a steel which shall be easy to harden, free from distortion and show minimum dilatation during treatment, and Jessop's Superior Oil-Hardening Steel meets these requirements. These properties have been produced by a proper combination of the carbon, manganese and tungsten contents, making the material essentially oil-hardening steel, and under no circumstances should tools made from it be hardened in water. Another advantage possessed by this Steel in the annealed condition is its remarkably free cutting properties, so that it responds readily to all types of machining operations.

**Annealing:** Heat to 1380° F. for 30 minutes to 12 hours, according to size of tool and results required, and allow to cool slowly.

**Forging:** Heat to 1575° F. and hammer carefully. Do not continue hammering below 1100° F.

**Hardening:** Heat slowly to 1400° F. and allow to soak 5 or 10 minutes longer than would be required for a corresponding carbon tool, and quench in thin oil. For very intricate tools or where a minimum distortion is required, allow the tool to cool to 1300° F. in the furnace prior to quenching.

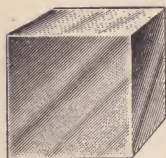
**Tempering:** Temper at 450° F. for 20 minutes.

*Note:* On no account must water quenching be adopted with this Steel.

**Subject to Carbon Steel Classification of extras**

## TOOL STEEL

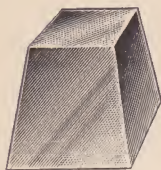
### FORGINGS



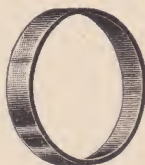
Cubes



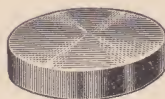
Oblongs



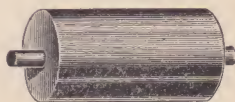
Bevelled



Rings



Blanks



Rolls

Rings and Forgings of irregular shapes made of Tool Steel.  
Also Annealed Cutter Blanks supplied promptly from stock or made to order.  
Price list of sizes sent on request.

## Classification of Extras Carbon Tool Steel

### ROUND, SQUARE, OCTAGON AND HEXAGON

All dimensions inclusive

Inches	Extra Per Lb. Cents
$\frac{5}{8}$ to 2 in. ....	<b>Base</b>
$2\frac{1}{8}$ to 3 in. ....	1.0
$3\frac{1}{8}$ to 4 in. ....	1.5
$4\frac{1}{8}$ to 5 in. ....	2.0
$5\frac{1}{8}$ to 6 in. ....	2.5
$6\frac{1}{8}$ to 7 in. ....	3.0
$7\frac{1}{8}$ to 8 in. ....	3.5
$\frac{9}{16}$ to $\frac{1}{2}$ in. ....	0.5
$\frac{7}{16}$ to $\frac{3}{8}$ in. ....	1.0
$\frac{5}{16}$ and $\frac{11}{32}$ in. ....	2.0
$\frac{1}{4}$ and $\frac{9}{32}$ in. ....	3.0
$\frac{3}{16}$ in. ....	5.0
$\frac{5}{32}$ in. ....	10.0
$\frac{1}{8}$ in. Square ....	18.0
$\frac{1}{8}$ in. Round ....	50.0

Intermediate sizes take next higher extra

Annealing.....1c per lb. extra



## Classification of Extras Carbon Tool Steel

(Continued)

### FLAT

Inches	Extra Per Lb. Cents	Inches	Extra Per Lb. Cents
$\frac{3}{8}$ to 2 in. thick x $\frac{9}{16}$ to 2 in. wide		Base	
$\frac{1}{8}$ x $\frac{1}{8}$	20.0	$\frac{1}{8}$ x $\frac{3}{8}$ to $\frac{5}{8}$	1.5
$\frac{1}{8}$ x $\frac{1}{4}$	15.0	$\frac{1}{8}$ x $\frac{11}{16}$ to 8	1.0
$\frac{1}{8}$ x $\frac{5}{16}$	8.0	$\frac{3}{8}$ x $\frac{7}{8}$ to 8	1.0
$\frac{1}{8}$ x $\frac{3}{8}$	4.0	$\frac{1}{2}$ x $\frac{1}{2}$ to 8	1.0
$\frac{1}{8}$ x $\frac{7}{8}$ to $\frac{1}{2}$	3.0	$\frac{1}{2}$ x $\frac{9}{16}$ to 8	1.0
$\frac{1}{8}$ x $\frac{9}{16}$ to 7	2.0	$\frac{9}{16}$ x $2\frac{1}{8}$ to 8	1.0
$\frac{1}{8}$ x $7\frac{1}{8}$ to 8	3.0	$\frac{5}{8}$ to 2 x $2\frac{1}{8}$ to 7	1.0
$\frac{3}{16}$ x $\frac{1}{4}$	5.0	$\frac{5}{8}$ to $1\frac{3}{4}$ x $7\frac{1}{8}$ to 8	1.0
$\frac{3}{16}$ x $\frac{5}{16}$	4.0	$1\frac{7}{8}$ to 2 x $7\frac{1}{8}$ to 8	1.5
$\frac{3}{16}$ x $\frac{3}{8}$	3.0	$2\frac{1}{8}$ to 3 x $2\frac{1}{8}$ to 5	1.0
$\frac{3}{16}$ x $\frac{7}{16}$ to $\frac{5}{8}$	2.0	$2\frac{1}{8}$ to 3 x $5\frac{1}{8}$ to 8	1.5
$\frac{3}{16}$ x $\frac{11}{16}$ to 2	1.5	$3\frac{1}{8}$ to 4 x $3\frac{1}{8}$ to 6	1.5
$\frac{3}{16}$ x $2\frac{1}{8}$ to 7	1.0	$3\frac{1}{8}$ to 4 x $6\frac{1}{8}$ to 8	2.0
$\frac{3}{16}$ x $7\frac{1}{8}$ to 8	2.0	$4\frac{1}{8}$ to 5 x $4\frac{1}{8}$ to 7	2.0
$\frac{1}{4}$ x $\frac{5}{16}$ to $\frac{3}{8}$	2.0	$4\frac{1}{8}$ to 5 x $7\frac{1}{8}$ to 8	2.5
$\frac{1}{4}$ x $\frac{7}{16}$ to $\frac{5}{8}$	1.5	$5\frac{1}{8}$ to 6 x $5\frac{1}{8}$ to 8	2.5
$\frac{1}{4}$ x $\frac{11}{16}$ to 2	1.5	$6\frac{1}{8}$ to 7 x $6\frac{1}{8}$ to 7	3.0
$\frac{1}{4}$ x $2\frac{1}{8}$ to 7	1.0	$6\frac{1}{8}$ to 8 x $7\frac{1}{8}$ to 8	3.5
$\frac{1}{4}$ x $7\frac{1}{8}$ to 8	2.0		

Intermediate sizes take the next higher extra

### Cutting to Specified Single and Multiple Lengths

	Extra Per Lb. Cents
24 in. and over	0.5
18 to $23\frac{1}{8}$ in.	1.0
12 to $17\frac{1}{8}$ in.	1.5
6 to $11\frac{1}{8}$ in.	2.0

Less than 6 in., special price

## SHEETS AND STRIPS

### HOT ROLLED CARBON TOOL STEEL

For Cutlery, Saws, Springs, Slotting Saws, Hack Saws, Gin Saws,  
and all general purposes

CAST SHEET STEEL { YELLOW LABEL  
GREEN LABEL  
BLACK LABEL

Furnished in gauges from  $\frac{1}{4}$ " thick to .009 (32 B.W. Gauge) in lengths 4 to 7 feet, and widths up to 20 inches.

These sheets are rolled flat, accurate to gauge, free from all surface imperfections, and can be furnished in the Unannealed or Annealed condition as required.

## CIRCULAR SAW PLATES

A complete line of all standard sizes of Best Quality Steel Plates suitable for wood saws is available.

This Steel is manufactured of carefully selected base materials, under rigid mill inspection, and embodies all the essentials demanded by the saw manufacturer. The extreme care carried out in the various processes is a guarantee of homogeneous steel, uniform rolling, accurate shearing and freedom from pit marks and other surface blemishes.

## ALLOY SAW STEELS

We also furnish on special order, Alloy Steel Plates, Sheets or Strips for wood and metal cutting.

## HACK SAW STEEL

HACK SAW SHEETS are made in two grades—Carbon and Tungsten.

Our Hack Saw Sheets are used in all countries where hack saws are produced.

The steel is produced from Swedish base melted in crucibles, and the product is not only critically examined in the finished stage, but also in the intermediate states of slabs and moulders. All surface defects are removed in these stages, so that the finished sheets are free from all surface blemishes.

The essential characteristics of Hack Saw Steels are that the sheets should be flat and have a firmly adherent scale which readily detaches itself in hardening. At the same time the sheet should be reasonably stiff, but free from mechanical stresses which cause distortion during hardening. Owing to the fact that prolonged heating around about the critical temperature puts the tungsten into a state in which its cutting properties cannot be developed during ordinary hardening operations, the solution of all these problems has had to be found in the method of rolling. In our Mills a special study has been made of this product, and the correct rolling conditions defined both as regards to temperatures and pressure of rolls. As a result we can guarantee our product flat, accurate to gauge, with a thin adherent scale readily removed during hardening, and at the same time to be in a condition to develop its full cutting properties after hardening.

## Classification of Extras Carbon Sheet Tool Steel

	Extra Per Lb. Cents		Extra Per Lb. Cents
<b>No. 14 ga. (.083) and Heavier.....</b>			<b>Base</b>
No. 15 ga. (.072) .....	0.25	No. 24 ga. (.022) .....	4.00
No. 16 ga. (.065) .....	0.25	No. 25 ga. (.020) .....	5.00
No. 17 ga. (.058) .....	0.50	No. 26 ga. (.018) .....	6.00
No. 18 ga. (.049) .....	0.75	No. 27 ga. (.016) .....	50.00
No. 19 ga. (.042) .....	1.00	No. 28 ga. (.014) .....	50.00
No. 20 ga. (.035) .....	1.25	No. 29 ga. (.013) .....	50.00
No. 21 ga. (.032) .....	1.50	No. 30 ga. (.012) .....	52.00
No. 22 ga. (.028) .....	2.00	No. 32 ga. (.009) .....	80.00
No. 23 ga. (.025) .....	3.00		

Thicknesses specified in above list are Birmingham or Stubbs gauge.

Annealing ..... 2c per lb. extra  
 Shearing ..... per cut

## Classification of Extras Circular Saw Plates

	Extra Per Lb. Cents
<b>10 to 46 in. ....</b>	<b>Base</b>
4 and 5 in. diameter .....	6.0
6 and 7 in. diameter .....	4.0
8 and 9 in. diameter .....	2.0
48 in. diameter .....	1.0
50 in. diameter .....	2.0
52 and 54 in. diameter .....	3.0
56 to 60 in. diameter .....	5.0
62 and 64 in. diameter .....	7.0

Intermediate sizes take the next higher extra.

Diameters larger than 64 in. subject to special quotations.

## HIGH SPEED STEELS

WM. JESSOP & SONS' "SUPERIOR" HIGH-SPEED CAST STEEL

William Jessop & Sons, Limited, have developed four brands of High Speed Steels to cover all purposes.

**"ARK"** is a 14 per cent. tungsten steel particularly suitable for making twist drills where the ability to resist torsional strain is at least of equal importance with the cutting ability of this class of tool.

**"ARK SUPERIOR."** This is an 18 per cent. tungsten steel, suitable for turning tools, milling cutters, etc., used under ordinary conditions.

**"ARK SUPERIOR FOR CAST IRON."** This is also an 18 per cent. tungsten steel, with a higher chrome content than the ordinary grade, and is particularly suitable for turning iron castings which are liable to be hard and also contain inclusions of sand. On such work the ordinary brands of high speed steel do not stand up as well, hence the new development.

**"ARK SUPERLATIVE"** is the latest development in high speed steel, developed to meet the demand for machining such material as manganese steel, brake-hardened and worn tires, sorbitic tires, etc.

**ALL THESE BRANDS OF HIGH SPEED STEEL CAN BE OBTAINED in all sizes of Tool Holder Bits.**

**Forging:** Heat slowly to 2000° F. and hammer carefully. If temperature drops below 1700° F., reheat to 2000° F. before completing forging operation.

**Annealing:** Pack in lime, charcoal or iron borings and heat to 1550° F. for two to six hours and then allow to cool down slowly in furnace.

**Hardening:** Preheat to 1300° F., then transfer to a furnace heated to 2300° F. for 14 per cent. tungsten steels and 2400° F. for 18 per cent. tungsten steels. As soon as the cutting edges have attained the temperature of the furnace, cool off in air blast or quench in oil. Draw or temper at 1100° F.



## HIGH SPEED STEELS

(Continued)

*Grinding* probably plays a greater part in determining the life of a high speed tool than that of a carbon tool. The highly alloyed nature of high speed steel results in the steel becoming hardened throughout, while with carbon steels the hardness is more or less superficial. This accounts for the greater tendency of high speed steels to surface cracking unless grinding conditions are ideal. Whenever possible wet grinding should be resorted to, using an ample stream of cold water. The wheels used should be both coarser and softer than the grade used for carbon steels. When dry grinding is imperative, then it is advisable to use very light cuts and slow traverses. In either case it is essential to keep the wheel well dressed, as nothing is more likely to bring about the failure of a tool in use than grinding with a glazed wheel.

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### SUPERIOR "ARK" HIGH SPEED STEEL TOOL HOLDER BITS



Sizes and lengths carried in stock :

- $\frac{1}{8}$  in. square, 2 in. long
- $\frac{1}{4}$  in. square, 2 in. long
- $\frac{5}{8}$  in. square,  $2\frac{1}{2}$  in. long
- $\frac{3}{8}$  in. square, 3 in. long
- $\frac{1}{2}$  in. square, 3 and  $3\frac{1}{2}$  in. long
- $\frac{1}{2}$  in. square, 4 in. long
- $\frac{5}{8}$  in. square,  $4\frac{1}{2}$  in. long
- $\frac{3}{4}$  in. square, 5 in. long

Special lengths and sizes made to order.

## Classification of Extras—High Speed Steel

### ROUNDS AND SQUARES

Inches	Extra Per Lb. Cents	Inches	Extra Per Lb. Cents
$\frac{5}{8}$ to 2 in. ....			Base
$\frac{1}{8}$ to $\frac{1}{2}$ .....	2.0	$3\frac{3}{8}$ to 4 .....	3.5
$\frac{1}{8}$ to $\frac{3}{8}$ .....	3.5	$4\frac{1}{8}$ to $4\frac{1}{2}$ .....	4.0
$\frac{1}{8}$ to $\frac{1}{2}$ .....	6.0	$4\frac{5}{8}$ to 5 .....	4.5
$\frac{1}{4}$ to $\frac{3}{4}$ .....	8.5	$5\frac{1}{8}$ to $5\frac{1}{2}$ .....	5.0
$2\frac{1}{8}$ to $2\frac{1}{2}$ .....	2.0	$5\frac{3}{8}$ to 6 .....	5.5
$2\frac{5}{8}$ to 3 .....	2.5	$6\frac{1}{8}$ to $6\frac{1}{2}$ .....	6.0
$3\frac{1}{8}$ to $3\frac{1}{2}$ .....	3.0	$6\frac{5}{8}$ to 7 .....	6.5

Intermediate sizes take the next higher extra.

### FLATS

Inches	Extra Per Lb. Cents	Inches	Extra Per Lb. Cents
$\frac{5}{8}$ to 2 in. thick by $\frac{5}{8}$ to 2 in. wide .....			Base
$\frac{1}{8}$ x $\frac{1}{8}$ .....	40.0	$\frac{3}{8}$ x $\frac{7}{8}$ to $1\frac{1}{2}$ .....	3.0
$\frac{1}{8}$ x $\frac{1}{4}$ .....	30.0	$\frac{3}{8}$ x $1\frac{5}{8}$ to 5 .....	2.5
$\frac{1}{8}$ x $\frac{1}{8}$ .....	20.0	$\frac{1}{2}$ x $\frac{1}{2}$ to 1 .....	3.0
$\frac{1}{8}$ x $\frac{3}{8}$ to 3 .....	14.0	$\frac{1}{2}$ x $1\frac{1}{8}$ to $5\frac{1}{2}$ .....	2.5
$\frac{1}{8}$ x $\frac{1}{4}$ to 3 .....	14.0	$\frac{1}{2}$ x $\frac{5}{8}$ to 1 .....	2.5
$\frac{1}{4}$ x $\frac{5}{8}$ to $\frac{1}{2}$ .....	8.0	$\frac{1}{2}$ x $1\frac{1}{8}$ to 6 .....	2.0
$\frac{1}{4}$ x $\frac{5}{8}$ to 1 .....	5.0	$\frac{1}{2}$ x $\frac{5}{8}$ to 1 .....	2.5
$\frac{1}{4}$ x $1\frac{1}{8}$ to 4 .....	3.0	$\frac{1}{2}$ x $1\frac{1}{8}$ to 6 .....	2.0
$\frac{1}{8}$ x $\frac{3}{8}$ to $\frac{5}{8}$ .....	5.0	$\frac{5}{8}$ to 2 x $2\frac{1}{8}$ to 4 .....	2.0
$\frac{1}{8}$ x $\frac{3}{4}$ to 1 .....	3.5	$\frac{5}{8}$ to 2 x $4\frac{1}{8}$ to 7 .....	4.0
$\frac{1}{8}$ x $1\frac{1}{8}$ to $4\frac{1}{2}$ .....	3.0	$2\frac{1}{8}$ to 3 x $2\frac{1}{8}$ to 4 .....	2.0
$\frac{3}{8}$ x $\frac{1}{2}$ to $\frac{3}{4}$ .....	3.0	$2\frac{1}{8}$ to 3 x $4\frac{1}{8}$ to 7 .....	4.0

Intermediate sizes take next higher extra.

All dimensions inclusive.

Annealing ..... per lb. 2c

### Cutting to Specified Single and Multiple Lengths

	Extra Per Lb. Cents
24 in. and over .....	1.0
18 to $23\frac{1}{8}$ in. ....	2.0
12 to $17\frac{1}{8}$ in. ....	3.0
6 to $11\frac{1}{8}$ in. ....	4.0

Less than 6 in.—Special Price

## SPECIAL STEELS

### COMPOSITE DIE STEEL

**Part Iron and Part Best Die Steel, carefully annealed**

This material possesses distinct advantages for certain classes of tools because of the toughness imparted by the iron backing, which being of the best Swedish quality, remains soft after the hardening operation.

We carry in stock an assortment of sizes of half iron and half steel from  $\frac{3}{4} \times \frac{3}{8}$  to  $7 \times 1\frac{1}{2}$ .

Other sizes or other proportions of iron to steel will be supplied from the mill at short notice.

**Subject to Carbon Tool Steel Classification of Extras**

### DURO STEEL

is a Crucible Cast Steel, alloyed with tungsten to refine the grain and produce a steel which is harder and possesses greater cutting capacity than a straight carbon steel. This renders the material specially suitable for such tools as twist drills, chasers, thread rolling dies, taps and similar tools.

This brand can be used with equal satisfaction as an oil-hardening or a water-hardening steel.

**Hardening:** Heat to  $1500^{\circ}$  F. for water quenching, and to  $1575^{\circ}$  F. for oil quenching. Temper as for carbon steel tools of similar types.

**Subject to Carbon Steel Classification of Extras**

## SPECIAL STEELS

(Continued)

### ALLOY "B" STEEL

#### FOR FAST FINISHING WORK

This Steel is a high carbon, chrome tungsten steel capable of taking and maintaining a keen cutting edge at speeds higher than those used in the case of plain carbon steels, and was originally evolved to make up the well known deficiencies of high speed steel for finishing work, and also for the production of such tools as barrel bits, which are required for drilling long holes. Subsequent investigation showed that the special properties of the steel made it particularly adaptable for machining ebonite, vulcanite and bakelite; for turning chilled rolls, and also for drawing dies, especially those used in the copper and brass trades.

**Annealing:** Heat slowly to 1450° F.; maintain at this temperature for about 50 per cent. longer time than for straight carbon steel and cool slowly.

**Hardening:** Heat slowly to 1500° F.; soak for about 50 per cent. longer time than for carbon steel. Cutting tools should be quenched in water and drawing dies quenched in oil. Temper cutting tools at 450° F., and dies at 550° F., for 30 minutes.

**Subject to High Speed Steel Classification of Extras**

## SPECIAL STEELS

(Continued)

### ALLOY "C" STEEL

#### FOR HIGH PRODUCTION WORK

This is a very high carbon, highly alloyed Steel on which we have spent many years of systematic research to develop a steel which should be capable of deep hardening and possess great resistance to abrasive wear. The steel resists scaling during heating to a high degree; is capable of either air or oil hardening, during which operation the material undergoes remarkably little distortion. After hardening, the steel resists tempering to a degree which is remarkable, and in this sense the material can be regarded as intermediate between the carbon and high-speed steels.

This unique combination of properties makes the steel admirably suitable for all classes of blanking, drawing and trimming dies and punches. Other uses are for bakelite moulds, edging and crimping rolls, extrusion dies, wire drawing dies, master hobs and gauges.

**Forging:** This Steel being of a very dense nature should be handled just as carefully as high-speed steel in forging. Heat to 2000° F., taking care to thoroughly soak, and do not continue forging operations below 1600° F.

**Annealing:** Heat to 1650° F., and allow to cool in furnace.

**Hardening:** Heat slowly and carefully to 1850° F., soak thoroughly, and then cool in air or quench in oil. Oil-quenching gives a greater depth of hardening than air-cooling. Always remember that alloy steels require a much longer soaking time than straight carbon steels, and this factor increases with increasing alloy content. Temper at 600° F., preferably before the material has gone quite cold in the cooling operation.

**Subject to High Speed Steel Classification of Extras**



## SPECIAL STEELS

(Continued)

### B. B. HOT DIE STEEL

This Steel is a highly alloyed tungsten steel which has the property of retaining its hardness at high temperatures, compared with the usual grades of hot die steel.

It can therefore be used to advantage for hot heading, gripper and forging dies, piercing tools and punches, etc. While its initial cost is materially higher than that of the ordinary carbon, nickel or nickel chrome die steels, experience on long runs has proved that by its use the die cost per component produced is reduced to less than one-third.

**Forging:** Heat slowly to 2000° F. and hammer carefully. If temperature drops below 1700° F., reheat to 2000° F. before completing forging operation.

**Annealing:** Heat to 1550° F. for two hours and allow to cool very slowly; preferably in the furnace.

**Hardening:** Heat to 1900° F.; soak thoroughly and allow to cool in air or an air blast.

Subject to High Speed Steel Classification of Extras

## SPECIAL STEELS

(Continued)

### "J-4" CHISEL STEEL

This is a high grade Crucible Alloy Tool Steel whose composition is such that, properly treated, it combines cutting properties with toughness and durability. This combination makes it ideal for all types of shock tools, and it can be used to the greatest advantage for Hand and Pneumatic Chisels, Sets, Stone Chisels, etc.

**Forging:** Heat slowly and thoroughly to a dull yellow (about 2000° F.) and cease forging when the temperature has dropped to a bright red (about 1475° F.).

**Hardening:** Heat slowly and carefully to a temperature of 1525°-1575° F. (bright cherry red). Soak thoroughly and quench in thin oil.

**Tempering:** Unnecessary, except in the case of very thin sections, which should be tempered to a pale yellow color (425° F.)

In the manufacture of Pneumatic Chisels, after machining the shank and forging the cutting edge, heat the whole Chisel to 1525°-1575° F., and allow to cool in air prior to hardening the cutting edge.

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## OTHER SPECIALTIES

Cold Drawn Tool Steels

Cold Rolled Tool Steels

in Bars, Sheets, Strips and Coils

Cold Rolled Pen Steel

Truss Spring Steel

Self-Hardening Steel

Double Shear Steel

Drill Steel

Valve Steels

File Steel

etc., etc.

## Notes on the Principles Underlying the Heat Treatment of Steels

HARDENING is of course the most important operation in tool production and one which should be carried out with the precision of a machining operation in order to get the best results.

A properly annealed straight carbon steel containing around about one per cent. carbon consists of a mixture of about 15 per cent. carbide of iron, known as cementite, the balance being iron, known as ferrite. The cementite may be distributed throughout the mass in the form of plates when the material is said to be pearlitic, or in the form of globules, when the material is spoken of as spheroidized. Either, or a combination of these states, may be produced by varying the conditions of annealing. On heating the Steel, as soon as a certain temperature known as the decalescence or critical point is reached, the whole of the carbide of iron tends to dissolve in or form a perfectly homogeneous mixture with the iron.

This temperature is in the neighborhood of 1360° F., and if the Steel be maintained at 1400°-1450° F. (according to carbon content) for a sufficient period of time, the whole of the cementite passes into solution, and in order to get perfect hardening it is necessary that this solution should be completed.

But at this temperature grain growth is fairly rapid, and if the heating be too prolonged, a coarse fracture is obtained after quenching. This gives the first precaution which should be taken, viz., the soaking time should be long enough to complete the change, but not long enough to bring about undue grain growth.

In this hot state the steel is said to be austenitic, and it is now in a condition to enter the hardened state. By the very rapid cooling induced by quenching, the steel remains hard, but slow cooling allows the steel to regain its soft or annealed condition to a degree which is determined by the rate of cooling. In order better to understand the mechanism of hardening, it is desirable first to investigate the changes which go on in the steel during slow cooling.

In the initial stages, the steel cools down at the same rate as the furnace until the temperature reaches the critical temperature on cooling known as decalescence. This temperature is 1290° F. for straight carbon steels, and 1250° F. for the high manganese type of oil-hardening steel. At this temperature the carbide of iron is rejected from

solution, and the heat of solution is evolved, causing a halt in the cooling. After the whole of the carbide has been rejected from solution, the steel then continues to cool down at the same rate as the furnace.

It will first be noticed that the decalescence point (Ac) is higher than the recalescence point (Ar), and this explains why a piece of steel will harden at a lower temperature on a "falling heat" than on a "rising heat," a fact which is well known to all practical hardeners. This temperature gap between the critical points on heating and cooling is of all-importance in the efficient heat treatment of steels. The rate of cooling through the Ac to Ar temperature range is by far the greatest factor in determining the final state of the hardened and tempered tool.

As may be expected, the reformation of the carbide from solution takes place in several stages, the first stage being the formation of minute particles which gradually grow from ultra-microscopic size into globules which can be readily distinguished under the microscope. In this state the steel is said to be sorbitic. If the cooling is carried on at a still slower rate, the particles associate themselves into plates or rods, and give rise to pearlite, which is the common form of fully annealed carbon steel. By reheating this fully annealed steel to a temperature between the Ar and the Ac point, say 1330° F., these plates or rods of cementite coalesce into globules again, and the steel is said to be "spheroidized," which condition is maintained if the cooling be fairly rapid.

Having got the picture of the effects of slow cooling in our minds, we can now pass on to a consideration of the effects of very rapid cooling or quenching.

Quenching acts by preventing or tending to prevent the precipitation of the carbon from solution in the form of cementite. But in straight carbon steels the precipitation is so rapid that it is impossible to prevent it altogether, except by the drastic method of quenching in liquid air. After such treatment the steel is quite homogeneous, and said to be austenitic. Strangely enough, this condition is not that of maximum hardness. Quenching in cold water or brine brings about a kind of intermediate state between the austenitic and the sorbitic, in which a certain proportion of the carbon has been rejected from solution in the form of extremely minute particles uniformly distributed throughout this mass, and it is this factor which is the principal cause of the hardness of steel. Added to this, there is the molecular stress set up by the effort of the dissolved carbide to revert to its stable or undissolved condition, which contributes its quota to the hardness.

During the quenching operation the outer layers of the steel being in contact with the quenching medium, lose their heat rapidly, but the



heat of the interior has to be dissipated through the outer layers. As a result of this, the outer layers tend to contract on the interior, and this sets up internal stresses purely of a mechanical nature. These internal stresses may become great enough to cause rupture of the steel, a tendency which increases with the mass of material. The study of these internal stresses is of great importance to the practical hardener in carrying out hardening with a minimum amount of cracking. Irregular heating or cooling, of course, affects the distribution of the stresses, and irregularly distributed stresses are much more liable to cause cracking than stresses which are distributed uniformly. This accounts for the greater tendency of intricate sections and those containing sharp corners to crack.

Fortunately on reheating the hardened steel, internal stresses are released at lower temperatures, and at greater rates than hardness is lost. In fact it can be stated categorically that a properly hardened steel does not lose any of its hardness at temperatures below 350° F., while even boiling in water allows the release of a considerable amount of the internal stress.

With regard to quenching media, it is a well known fact that their hardening power is rapidly lost as the temperature increases. This is particularly the case with water, the hardening power of which rapidly decreases with rising temperature.

In spite of all this, water is the best quenching medium for carbon tool steels, but the tool should be moved about in the water, of which there should be a supply sufficient to keep the temperature below 85° F. On the other hand, very cold water is liable to cause cracking by increasing the internal stresses. Consequently the temperature of the water should not be allowed to fall below 65° F.

Brine does not lose its quenching power with rise of temperature at anything like the same rate that water does, and this is the only reason for its use. If a supply of running water is not available, then it is advisable to use brine. It is commonly thought that steel quenched in brine is harder than steel quenched in water, but this is only true when so many pieces have been quenched that the liquids have become appreciably heated. As a quenching fluid, brine should be regarded as an adjunct to and not a substitute for water—it is useful when a supply of running water and an adequate sized tank are not available, or when a large number of small tools or components are treated by the method of dump hardening.

From these brief notes, the following precautions in the hardening of carbon steel tools can be deduced:



1. Use a furnace which is uniformly heated, so that temperature gradients are absent.
2. Heat the tools slowly and uniformly to the hardening temperature.
3. Soak long enough to get the whole of the carbon into solution.
4. Do not soak too long nor exceed the hardening temperature, as crystalline growth, leading to coarse fracture, proceeds very rapidly at high temperatures.
5. See that the temperature of the quenching bath is in the neighborhood of 70° F.
6. Remove the tool from the furnace into the quenching bath as rapidly as possible.
7. Keep either the tool or the water moving during the immersion period.
8. Remove the tool from the quenching medium when it is still warm to the hand, and place it in the tempering bath immediately.
9. Temper at as high a temperature as possible for at least twenty minutes. Tempering can be carried out at 350° F. for every possible type of tool and at 450° F. for most tools.

### **Oil-Hardening Steels**

All the above remarks, both with regard to the theory as well as the precautions to be taken, apply to Oil-Hardening Steels. The only difference is that oil is used instead of water as a quenching medium. In this respect it should be understood that the thinner the oil the greater the hardening power. The necessary steps should be taken to cool the oil and keep it in the neighborhood of 75°-85° F.

### **Alloy Steels**

The effect of those elements which are added to tool steels are three-fold. In the first place they affect the position of the critical points; secondly, they decrease the rate at which the dissolved carbides are rejected from solution, and then tend to render the steels self-hardening; and thirdly, they may completely modify the properties of the steel by the formation of complex carbides, as in the case of high speed steels. But in a general way, the theoretical aspect is very similar to that enunciated for straight carbon steels.

If the alloy steels are of the quenching type, the same precautions as for carbon steel should be taken with the necessary temperature modifications. At the same time it should be remembered that the time of soaking should be longer in order to get the less mobile alloy elements into solution.

Close adherence to these precautions will have a great influence in eliminating hardening troubles.

## Weight of Bar Steel Per Lineal Foot

Size	Round	Square	Hexagon	Octagon
$\frac{1}{8}$ "	.04	.05	.05	.04
$\frac{3}{16}$ "	.09	.12	.10	.10
$\frac{1}{4}$ "	.17	.21	.19	.18
$\frac{5}{16}$ "	.26	.33	.29	.28
$\frac{3}{8}$ "	.38	.48	.42	.40
$\frac{7}{16}$ "	.51	.65	.57	.54
$\frac{1}{2}$ "	.67	.85	.75	.70
$\frac{9}{16}$ "	.85	1.08	.94	.89
$\frac{5}{8}$ "	1.04	1.33	1.17	1.10
$\frac{11}{16}$ "	1.27	1.61	1.41	1.33
$\frac{3}{4}$ "	1.50	1.92	1.68	1.58
$\frac{13}{16}$ "	1.76	2.24	1.97	1.83
$\frac{7}{8}$ "	2.04	2.60	2.29	2.16
$\frac{15}{16}$ "	2.35	3.06	2.62	2.48
1 "	2.67	3.40	2.99	2.82
$1\frac{1}{8}$ "	3.38	4.30	3.78	3.56
$1\frac{1}{4}$ "	4.17	5.31	4.66	4.40
$1\frac{3}{8}$ "	5.05	6.43	5.65	5.32
$1\frac{1}{2}$ "	6.01	7.65	6.72	6.34
$1\frac{5}{8}$ "	7.05	8.98	7.89	7.32
$1\frac{3}{4}$ "	8.18	10.40	9.14	8.64
$1\frac{7}{8}$ "	9.38	11.90	10.50	9.92
2 "	10.71	13.60	11.95	11.28
$2\frac{1}{8}$ "	12.05	15.40	13.49	12.71
$2\frac{1}{4}$ "	13.60	17.20	15.12	14.24
$2\frac{3}{8}$ "	15.10	19.20	16.85	15.88
$2\frac{1}{2}$ "	16.68	21.20	18.66	17.65

For High-Speed Steel add Approximately 10%

## Weight of Bar Steel Per Lineal Foot

(Continued)

Size	Round	Square	Hexagon	Octagon
2 $\frac{5}{8}$ "	18.39	23.50	20.58	19.45
2 $\frac{3}{4}$ "	20.18	25.70	22.59	21.28
2 $\frac{7}{8}$ "	22.06	28.20	24.69	23.28
3 "	24.10	30.60	26.88	25.36
3 $\frac{1}{8}$ "	26.12	33.13	29.16	27.50
3 $\frac{1}{4}$ "	28.30	35.90	31.55	29.28
3 $\frac{3}{8}$ "	30.45	38.64	34.00	32.10
3 $\frac{1}{2}$ "	32.70	41.60	36.59	34.56
3 $\frac{5}{8}$ "	35.20	44.57	39.24	37.05
3 $\frac{3}{4}$ "	37.54	47.80	42.00	39.68
4 "	42.72	54.40	47.78	45.12
4 $\frac{1}{4}$ "	48.30	61.40	53.95	50.84
4 $\frac{1}{2}$ "	54.60	68.90	60.48	56.96
4 $\frac{3}{4}$ "	60.30	76.70	67.39	63.52
5 "	66.80	85.00	74.66	70.60
5 $\frac{1}{4}$ "	73.60	93.70	82.32	77.80
5 $\frac{1}{2}$ "	80.80	102.80	90.36	85.15
5 $\frac{3}{4}$ "	88.30	112.40	98.76	93.12
6 "	96.10	122.40	107.52	101.45
6 $\frac{1}{2}$ "	113.20	143.60	126.20	117.12
7 "	130.80	166.40	146.36	138.24
8 "	170.88	217.60	191.12	180.48
9 "	218.40	275.60	241.92	227.84
10 "	267.20	340.00	298.64	282.40
11 "	323.00	411.20	361.44	340.60
12 "	384.00	489.60	470.08	405.80

For High-Speed Steel add Approximately 10%

# Weight of Bar Steel Per Lineal Foot

(Continued)

## FLATS

Thickness Inches		WIDTH—INCHES																						
		½	¾	1	1 ¼	1 ½	1 ¾	2	2 ¼	2 ½	2 ¾	3	3 ¼	3 ½	3 ¾	4	4 ¼	4 ½	4 ¾	5				
1.060	1.381	1.594	1.859	2.12	2.391	2.656	2.92	3.19	3.46	3.72	4.25	4.78	5.31	5.84	6.38	6.91	7.44	7.97	8.50	8.5	9.0	9.6	1.01	1.06
1.125	1.446	1.711	1.976	2.241	2.506	2.771	3.036	3.301	3.566	3.831	4.36	4.89	5.42	5.95	6.48	7.01	7.54	8.07	8.60	9.13	9.66	10.19	10.72	11.25
1.187	1.508	1.773	2.038	2.303	2.568	2.833	3.098	3.363	3.628	3.893	4.42	4.95	5.48	6.01	6.54	7.07	7.60	8.13	8.66	9.19	9.72	10.25	10.78	11.31
1.250	1.570	1.835	2.100	2.365	2.630	2.895	3.160	3.425	3.690	3.955	4.48	5.01	5.54	6.07	6.60	7.13	7.66	8.19	8.72	9.25	9.78	10.31	10.84	11.37
1.312	1.632	1.897	2.162	2.427	2.692	2.957	3.222	3.487	3.752	4.017	4.54	5.07	5.60	6.13	6.66	7.19	7.72	8.25	8.78	9.31	9.84	10.37	10.90	11.43
1.375	1.694	1.959	2.224	2.489	2.754	3.019	3.284	3.549	3.814	4.079	4.60	5.13	5.66	6.19	6.72	7.25	7.78	8.31	8.84	9.37	9.90	10.43	10.96	11.49
1.437	1.756	2.021	2.286	2.551	2.816	3.081	3.346	3.611	3.876	4.141	4.67	5.20	5.73	6.26	6.79	7.32	7.85	8.38	8.91	9.44	9.97	10.50	11.03	11.56
1.500	1.818	2.083	2.348	2.613	2.878	3.143	3.408	3.673	3.938	4.203	4.73	5.26	5.79	6.32	6.85	7.38	7.91	8.44	8.97	9.50	10.03	10.56	11.09	11.62
1.562	1.880	2.145	2.410	2.675	2.940	3.205	3.470	3.735	3.999	4.264	4.79	5.32	5.85	6.38	6.91	7.44	7.97	8.50	9.03	9.56	10.09	10.62	11.15	11.68
1.625	1.942	2.207	2.472	2.737	3.002	3.267	3.532	3.797	4.062	4.327	4.85	5.38	5.91	6.44	6.97	7.50	8.03	8.56	9.09	9.62	10.15	10.68	11.21	11.74
1.687	1.999	2.264	2.529	2.794	3.059	3.324	3.589	3.854	4.119	4.384	4.91	5.44	5.97	6.50	7.03	7.56	8.09	8.62	9.15	9.68	10.21	10.74	11.27	11.80
1.750	2.061	2.316	2.581	2.846	3.111	3.376	3.641	3.906	4.171	4.436	4.96	5.49	6.02	6.55	7.08	7.61	8.14	8.67	9.20	9.73	10.26	10.79	11.32	11.85
1.812	2.123	2.378	2.643	2.908	3.173	3.438	3.703	3.968	4.233	4.498	5.02	5.55	6.08	6.61	7.14	7.67	8.20	8.73	9.26	9.79	10.32	10.85	11.38	11.91
1.875	2.185	2.440	2.705	2.970	3.235	3.500	3.765	4.030	4.295	4.560	5.09	5.62	6.15	6.68	7.21	7.74	8.27	8.80	9.33	9.86	10.39	10.92	11.45	11.98
1.937	2.247	2.502	2.767	3.032	3.297	3.562	3.827	4.092	4.357	4.622	5.15	5.68	6.21	6.74	7.27	7.80	8.33	8.86	9.39	9.92	10.45	10.98	11.51	12.04
2.000	2.309	2.564	2.829	3.094	3.359	3.624	3.889	4.154	4.419	4.684	5.21	5.74	6.27	6.80	7.33	7.86	8.39	8.92	9.45	9.98	10.51	11.04	11.57	12.10
2.062	2.371	2.626	2.891	3.156	3.421	3.686	3.951	4.216	4.481	4.746	5.27	5.80	6.33	6.86	7.39	7.92	8.45	8.98	9.51	10.04	10.57	11.10	11.63	12.16
2.125	2.433	2.688	2.953	3.218	3.483	3.748	4.013	4.278	4.543	4.808	5.33	5.86	6.39	6.92	7.45	7.98	8.51	9.04	9.57	10.10	10.63	11.16	11.69	12.22
2.187	2.495	2.750	3.015	3.280	3.545	3.810	4.075	4.340	4.605	4.870	5.40	5.93	6.46	6.99	7.52	8.05	8.58	9.11	9.64	10.17	10.70	11.23	11.76	12.29
2.250	2.557	2.812	3.077	3.342	3.607	3.872	4.137	4.402	4.667	4.932	5.46	5.99	6.52	7.05	7.58	8.11	8.64	9.17	9.70	10.23	10.76	11.29	11.82	12.35
2.312	2.619	2.874	3.139	3.404	3.669	3.934	4.199	4.464	4.729	4.994	5.52	6.05	6.58	7.11	7.64	8.17	8.70	9.23	9.76	10.29	10.82	11.35	11.88	12.41
2.375	2.681	2.936	3.201	3.466	3.731	3.996	4.261	4.526	4.791	5.056	5.58	6.11	6.64	7.17	7.70	8.23	8.76	9.29	9.82	10.35	10.88	11.41	11.94	12.47
2.437	2.743	2.998	3.263	3.528	3.793	4.058	4.323	4.588	4.853	5.118	5.64	6.17	6.70	7.23	7.76	8.29	8.82	9.35	9.88	10.41	10.94	11.47	12.00	12.53
2.500	2.805	3.060	3.325	3.590	3.855	4.120	4.385	4.650	4.915	5.180	5.71	6.24	6.77	7.30	7.83	8.36	8.89	9.42	9.95	10.48	11.01	11.54	12.07	12.60
2.562	2.867	3.122	3.387	3.652	3.917	4.182	4.447	4.712	4.977	5.242	5.77	6.30	6.83	7.36	7.89	8.42	8.95	9.48	10.01	10.54	11.07	11.60	12.13	12.66
2.625	2.929	3.184	3.449	3.714	3.979	4.244	4.509	4.774	5.039	5.304	5.83	6.36	6.89	7.42	7.95	8.48	9.01	9.54	10.07	10.60	11.13	11.66	12.19	12.72
2.687	2.991	3.246	3.511	3.776	4.041	4.306	4.571	4.836	5.101	5.366	5.89	6.42	6.95	7.48	8.01	8.54	9.07	9.60	10.13	10.66	11.19	11.72	12.25	12.78
2.750	3.053	3.308	3.573	3.838	4.103	4.368	4.633	4.898	5.163	5.428	5.95	6.48	7.01	7.54	8.07	8.60	9.13	9.66	10.19	10.72	11.25	11.78	12.31	12.84
2.812	3.115	3.370	3.635	3.900	4.165	4.430	4.695	4.960	5.225	5.490	6.02	6.55	7.08	7.61	8.14	8.67	9.20	9.73	10.26	10.79	11.32	11.85	12.38	12.91
2.875	3.177	3.432	3.697	3.962	4.227	4.492	4.757	5.022	5.287	5.552	6.08	6.61	7.14	7.67	8.20	8.73	9.26	9.79	10.32	10.85	11.38	11.91	12.44	12.97
2.937	3.239	3.494	3.759	4.024	4.289	4.554	4.819	5.084	5.349	5.614	6.14	6.67	7.20	7.73	8.26	8.79	9.32	9.85	10.38	10.91	11.44	11.97	12.50	13.03
3.000	3.301	3.556	3.821	4.086	4.351	4.616	4.881	5.146	5.411	5.676	6.20	6.73	7.26	7.79	8.32	8.85	9.38	9.91	10.44	10.97	11.50	12.03	12.56	13.09
3.062	3.363	3.618	3.883	4.148	4.413	4.678	4.943	5.208	5.473	5.738	6.26	6.79	7.32	7.85	8.38	8.91	9.44	9.97	10.50	11.03	11.56	12.09	12.62	13.15
3.125	3.425	3.680	3.945	4.210	4.475	4.740	5.005	5.270	5.535	5.800	6.33	6.86	7.39	7.92	8.45	8.98	9.51	10.04	10.57	11.10	11.63	12.16	12.69	13.22
3.187	3.487	3.742	4.007	4.272	4.537	4.802	5.067	5.332	5.597	5.862	6.39	6.92	7.45	7.98	8.51	9.04	9.57	10.10	10.63	11.16	11.69	12.22	12.75	13.28
3.250	3.549	3.804	4.069	4.334	4.599	4.864	5.129	5.394	5.659	5.924	6.45	6.98	7.51	8.04	8.57	9.10	9.63	10.16	10.69	11.22	11.75	12.28	12.81	13.34
3.312	3.611	3.866	4.131	4.396	4.661	4.926	5.191	5.456	5.721	5.986	6.51	7.04	7.57	8.10	8.63	9.16	9.69	10.22	10.75	11.28	11.81	12.34	12.87	13.40
3.375	3.673	3.928	4.193	4.458	4.723	4.988	5.253	5.518	5.783	6.048	6.57	7.10	7.63	8.16	8.69	9.22	9.75	10.28	10.81	11.34	11.87	12.40	12.93	13.46
3.437	3.735	3.990	4.255	4.520	4.785	5.050	5.315	5.580	5.845	6.110	6.64	7.17	7.70	8.23	8.76	9.29	9.82	10.35	10.88	11.41	11.94	12.47	13.00	13.53

For High-Speed Steel add Approximately 10%



# Weight of Bar Steel Per Lineal Foot

(Continued)

## FLATS

Thickness Inches	WIDTH—INCHES															
	5¼	5½	5¾	6	6¼	6½	6¾	7	7¼	7½	7¾	8	8¼	8½	8¾	9
1	1.116	1.169	1.222	1.275	1.328	1.381	1.434	1.487	1.540	1.594	1.647	1.70	1.753	1.806	1.859	1.913
1 1/8	1.232	1.338	1.444	1.550	1.656	1.762	1.869	1.975	2.081	2.188	2.294	2.401	2.508	2.615	2.722	2.829
1 1/4	1.35	1.51	1.67	1.83	1.99	2.15	2.31	2.47	2.63	2.79	2.95	3.11	3.27	3.43	3.59	3.75
1 1/2	1.47	1.68	1.89	2.10	2.31	2.52	2.73	2.94	3.15	3.36	3.57	3.78	3.99	4.20	4.41	4.62
1 3/4	1.59	1.84	2.09	2.34	2.59	2.84	3.09	3.34	3.59	3.84	4.09	4.34	4.59	4.84	5.09	5.34
1 7/8	1.71	2.00	2.29	2.58	2.87	3.16	3.45	3.74	4.03	4.32	4.61	4.90	5.19	5.48	5.77	6.06
2	1.83	2.16	2.49	2.82	3.15	3.48	3.81	4.14	4.47	4.80	5.13	5.46	5.79	6.12	6.45	6.78
2 1/8	1.95	2.33	2.71	3.09	3.47	3.85	4.23	4.61	4.99	5.37	5.75	6.13	6.51	6.89	7.27	7.65
2 1/4	2.07	2.50	2.93	3.36	3.79	4.22	4.65	5.08	5.51	5.94	6.37	6.80	7.23	7.66	8.09	8.52
2 1/2	2.19	2.66	3.13	3.60	4.07	4.54	5.01	5.48	5.95	6.42	6.89	7.36	7.83	8.30	8.77	9.24
2 3/4	2.31	2.82	3.33	3.84	4.35	4.86	5.37	5.88	6.39	6.90	7.41	7.92	8.43	8.94	9.45	9.96
2 7/8	2.43	2.98	3.53	4.08	4.63	5.18	5.73	6.28	6.83	7.38	7.93	8.48	9.03	9.58	10.13	10.68
3	2.55	3.14	3.73	4.32	4.91	5.50	6.09	6.68	7.27	7.86	8.45	9.04	9.63	10.22	10.81	11.40
3 1/8	2.67	3.30	3.93	4.56	5.19	5.82	6.45	7.08	7.71	8.34	8.97	9.60	10.23	10.86	11.49	12.12
3 1/4	2.79	3.46	4.13	4.80	5.47	6.14	6.81	7.48	8.15	8.82	9.49	10.16	10.83	11.50	12.17	12.84
3 1/2	2.91	3.62	4.33	5.04	5.75	6.46	7.17	7.88	8.59	9.30	10.01	10.72	11.43	12.14	12.85	13.56
3 3/4	3.03	3.78	4.53	5.28	6.03	6.78	7.53	8.28	9.03	9.78	10.53	11.28	12.03	12.78	13.53	14.28
3 7/8	3.15	3.94	4.73	5.52	6.31	7.10	7.89	8.68	9.47	10.26	11.05	11.84	12.63	13.42	14.21	15.00
4	3.27	4.10	4.93	5.76	6.59	7.42	8.25	9.08	9.91	10.74	11.57	12.40	13.23	14.06	14.89	15.72
4 1/8	3.39	4.26	5.13	6.00	6.87	7.74	8.61	9.48	10.35	11.22	12.09	12.96	13.83	14.70	15.57	16.44
4 1/4	3.51	4.42	5.33	6.24	7.15	8.06	8.97	9.88	10.79	11.70	12.61	13.52	14.43	15.34	16.25	17.16
4 1/2	3.63	4.58	5.53	6.48	7.43	8.38	9.33	10.28	11.23	12.18	13.13	14.08	15.03	15.98	16.93	17.88
4 3/4	3.75	4.74	5.73	6.72	7.71	8.70	9.69	10.68	11.67	12.66	13.65	14.64	15.63	16.62	17.61	18.60
4 7/8	3.87	4.90	5.93	6.96	7.99	9.02	10.05	11.08	12.11	13.14	14.17	15.20	16.23	17.26	18.29	19.32
5	3.99	5.06	6.13	7.20	8.27	9.34	10.41	11.48	12.55	13.62	14.69	15.76	16.83	17.90	18.97	20.04
5 1/8	4.11	5.22	6.33	7.44	8.55	9.66	10.77	11.88	12.99	14.10	15.21	16.32	17.43	18.54	19.65	20.76
5 1/4	4.23	5.38	6.53	7.68	8.83	9.98	11.13	12.28	13.43	14.58	15.73	16.88	18.03	19.18	20.33	21.48
5 1/2	4.35	5.54	6.73	7.92	9.11	10.30	11.49	12.68	13.87	15.06	16.25	17.44	18.63	19.82	21.01	22.20
5 3/4	4.47	5.70	6.93	8.16	9.39	10.62	11.85	13.08	14.31	15.54	16.77	18.00	19.23	20.46	21.69	22.92
5 7/8	4.59	5.86	7.13	8.40	9.67	10.94	12.21	13.48	14.75	16.02	17.29	18.56	19.83	21.10	22.37	23.64
6	4.71	6.02	7.33	8.64	9.95	11.26	12.57	13.88	15.19	16.50	17.81	19.12	20.43	21.74	23.05	24.36
6 1/8	4.83	6.18	7.53	8.88	10.23	11.58	12.93	14.28	15.63	16.98	18.33	19.68	21.03	22.38	23.73	25.08
6 1/4	4.95	6.34	7.73	9.12	10.51	11.90	13.29	14.68	16.07	17.46	18.85	20.24	21.63	23.02	24.41	25.80
6 1/2	5.07	6.50	7.93	9.36	10.79	12.22	13.65	15.08	16.51	17.94	19.37	20.80	22.23	23.66	25.09	26.52
6 3/4	5.19	6.66	8.13	9.60	11.07	12.54	14.01	15.48	16.95	18.42	19.89	21.36	22.83	24.30	25.77	27.24
6 7/8	5.31	6.82	8.33	9.84	11.35	12.86	14.37	15.88	17.39	18.90	20.41	21.92	23.43	24.94	26.45	27.96
7	5.43	6.98	8.53	10.08	11.63	13.18	14.73	16.28	17.83	19.38	20.93	22.48	24.03	25.58	27.13	28.68
7 1/8	5.55	7.14	8.73	10.32	11.91	13.50	15.09	16.68	18.27	19.86	21.45	23.04	24.63	26.22	27.81	29.40
7 1/4	5.67	7.30	8.93	10.56	12.19	13.82	15.45	17.08	18.71	20.34	21.97	23.60	25.23	26.86	28.49	30.12
7 1/2	5.79	7.46	9.13	10.76	12.42	14.09	15.76	17.43	19.10	20.77	22.44	24.11	25.78	27.45	29.12	30.79
7 3/4	5.91	7.62	9.33	11.00	12.71	14.42	16.13	17.84	19.55	21.26	22.97	24.68	26.39	28.10	29.81	31.52
7 7/8	6.03	7.78	9.57	11.31	13.06	14.81	16.56	18.31	20.06	21.81	23.56	25.31	27.06	28.81	30.56	32.31
8	6.15	7.94	9.77	11.64	13.51	15.38	17.25	19.12	20.99	22.86	24.73	26.60	28.47	30.34	32.21	34.08
8 1/8	6.27	8.10	9.97	11.88	13.81	15.74	17.67	19.60	21.53	23.46	25.39	27.32	29.25	31.18	33.11	35.04
8 1/4	6.39	8.26	10.17	12.14	14.11	16.08	18.05	20.02	21.99	23.96	25.93	27.90	29.87	31.84	33.81	35.78
8 1/2	6.51	8.42	10.37	12.40	14.42	16.43	18.44	20.45	22.46	24.47	26.48	28.49	30.50	32.51	34.52	36.53
8 3/4	6.63	8.58	10.57	12.66	14.71	16.76	18.81	20.86	22.91	24.96	27.01	29.06	31.11	33.16	35.21	37.26
8 7/8	6.75	8.74	10.77	12.92	15.01	17.09	19.17	21.25	23.33	25.41	27.49	29.57	31.65	33.73	35.81	37.89
9	6.87	8.90	10.97	13.18	15.30	17.42	19.54	21.66	23.78	25.90	28.02	30.14	32.26	34.38	36.50	38.62
9 1/8	6.99	9.06	11.17	13.44	15.61	17.78	19.94	22.10	24.26	26.42	28.58	30.74	32.90	35.06	37.22	39.38
9 1/4	7.11	9.22	11.37	13.70	15.92	18.14	20.36	22.58	24.80	27.02	29.24	31.46	33.68	35.90	38.12	40.34
9 1/2	7.23	9.38	11.57	14.00	16.24	18.51	20.78	23.05	25.32	27.59	29.86	32.13	34.40	36.67	38.94	41.21
9 3/4	7.35	9.54	11.77	14.26	16.52	18.84	21.16	23.48	25.80	28.12	30.44	32.76	35.08	37.40	39.72	42.04
9 7/8	7.47	9.70	12.01	14.52	16.84	19.21	21.58	23.96	26.34	28.72	31.10	33.48	35.86	38.24	40.62	42.99
10	7.59	9.86	12.27	14.78	17.16	19.68	22.10	24.52	26.94	29.36	31.78	34.20	36.62	39.04	41.46	43.88
10 1/8	7.71	10.02	12.53	15.04	17.56	20.18	22.68	25.18	27.68	30.18	32.68	35.18	37.68	40.18	42.68	45.18
10 1/4	7.83	10.18	12.79	15.30	17.88	20.49	23.02	25.54	28.06	30.58	33.10	35.62	38.14	40.66	43.18	45.70
10 1/2	7.95	10.34	13.01	15.56	18.16	20.82	23.38	25.92	28.46	30.99	33.52	36.05	38.58	41.11	43.64	46.17
10 3/4	8.07	10.50	13.23	15.82	18.48	21.14	23.76	26.32	28.88	31.44	34.00	36.56	39.12	41.68	44.24	46.80
10 7/8	8.19	10.66	13.45	16.08	18.80	21.46	24.08	26.66	29.24	31.82	34.40	36.98	39.56	42.14	44.72	47.30
11	8.31	10.82	13.67	16.34	19.12	21.78	24.40	27.00	29.60	32.20	34.80	37.40	40.00	42.60	45.20	47.80
11 1/8	8.43	11.00	13.91	16.60	19.44	22.10	24.72	27.34	30.00	32.66	35.32	37.98	40.64	43.30	45.96	48.62
11 1/4	8.55	11.16	14.13	16.86	19.76	22.42	25.04	27.68	30.36	33.04	35.72	38.40	41.08	43.76	46.44	49.12
11 1/2	8.67	11.32	14.35	17.12	20.08	22.74	25.36	28.00	30.68	33.36	36.04	38.72	41.40	44.08	46.76	49.44
11 3/4	8.79	11.48	14.57	17.38	20.40	23.06	25.68	28.32	31.00	33.68	36.36	39.04	41.72	44.40	47.08	49.76
11 7/8	8.91	11.64	14.79	17.64	20.72	23.38	26.00	28.64	31.32	34.00	36.68	39.36	42.04	44.72	47.40	50.08
12	9.03	11.80	15.01	17.90	21.04	23.70	26.32	28.96	31.64	34.32	37.00	39.68	42.36	45.04	47.72	50.40
12 1/8	9.15	12.02	15.23	18.16	21.36	24.02	26.64	29.28	31.96	34.64	37.32	40.				



## Weight of Sheet Steel

## Birmingham Wire Gauge

Gauge No.	Decimals of an Inch	Fractions of an Inch	Weight of One Square Foot, in Pounds
00000	.50	$\frac{1}{2}$	20.32
.....	.46875	$\frac{5}{8}$	19.05
0000	.454	..	18.46
....	.4375	$\frac{7}{16}$	17.78
000	.425	..	17.28
...	.40625	$\frac{3}{4}$	16.51
00	.380	..	15.45
..	.375	$\frac{3}{8}$	15.24
..	.34375	$\frac{1}{2}$	13.97
0	.340	..	13.82
..	.3125	$\frac{5}{16}$	12.70
1	.300	..	12.20
..	.296875	$\frac{19}{64}$	12.07
2	.284	..	11.55
..	.28125	$\frac{9}{32}$	11.43
..	.265625	$\frac{17}{64}$	10.80
3	.259	..	10.53
..	.250	$\frac{1}{4}$	10.16
4	.238	..	9.68
..	.234375	$\frac{15}{64}$	9.53
5	.220	..	8.95
..	.21875	$\frac{7}{32}$	8.89
6	.203125	$\frac{13}{64}$	8.26
..	.1875	$\frac{3}{16}$	7.62
7	.180	..	7.32
..	.171875	$\frac{11}{64}$	6.99
8	.165	..	6.71
..	.15625	$\frac{5}{32}$	6.35
9	.148	..	6.09
..	.140625	$\frac{9}{64}$	5.72
10	.134	..	5.45
..	.125	$\frac{1}{8}$	5.08

# Weight of Sheet Steel

## Birmingham Wire Gauge

### (Continued)

Gauge No.	Decimals of an Inch	Fractions of an Inch	Weight of One Square Foot, in Pounds
11	.120	..	4.88
12	.109375	$\frac{7}{64}$	4.44
13	.095	..	3.86
..	.09375	$\frac{3}{32}$	3.81
14	.083	..	3.37
..	.078125	$\frac{5}{64}$	3.18
15	.072	..	2.93
16	.065	..	2.64
..	.0625	$\frac{1}{16}$	2.54
17	.058	..	2.36
18	.049	..	1.99
..	.046875	$\frac{3}{64}$	1.91
19	.042	..	1.71
20	.035	..	1.42
21	.032	..	1.30
..	.03125	$\frac{1}{32}$	1.27
22	.028	..	1.14
23	.025	..	1.02
24	.022	..	.89
25	.020	..	.81
26	.018	..	.73
27	.016	..	.65
..	.015625	$\frac{1}{64}$	.64
28	.014	..	.57
29	.013	..	.53
30	.012	..	.49
31	.010	..	.41
32	.009	..	.37
33	.008	..	.33
34	.007	..	.28
35	.005	..	.20
36	.004	..	.16

## Average Weight of Circular Saw Plates

[illegible]

## Temperature Conversion Table

### EQUIVALENT TEMPERATURES IN CENTIGRADE AND FAHRENHEIT

Cent.°	Fahr.°	Cent.°	Fahr.°	Cent.°	Fahr.°	Cent.°	Fahr.°	Cent.°	Fahr.°
100	212	370	698	640	1184	910	1670	1180	2156
110	230	380	716	650	1202	920	1688	1190	2174
120	248	390	734	660	1220	930	1706	1200	2192
130	266	400	752	670	1238	940	1724	1210	2210
140	284	410	770	680	1256	950	1742	1220	2228
150	302	420	788	690	1274	960	1760	1230	2246
160	320	430	806	700	1292	970	1778	1240	2264
170	338	440	824	710	1310	980	1796	1250	2282
180	356	450	842	720	1328	990	1814	1260	2300
190	374	460	860	730	1346	1000	1832	1270	2318
200	392	470	878	740	1364	1010	1850	1280	2336
210	410	480	896	750	1382	1020	1868	1290	2354
220	428	490	914	760	1400	1030	1886	1300	2372
230	446	500	932	770	1418	1040	1904	1310	2390
240	464	510	950	780	1436	1050	1922	1320	2408
250	482	520	968	790	1454	1060	1940	1330	2426
260	500	530	986	800	1472	1070	1958	1340	2444
270	518	540	1004	810	1490	1080	1976	1350	2462
280	536	550	1022	820	1508	1090	1994	1360	2480
290	554	560	1040	830	1526	1100	2012	1370	2498
300	572	570	1058	840	1544	1110	2030	1380	2516
310	590	580	1076	850	1562	1120	2048	1390	2534
320	608	590	1094	860	1580	1130	2066	1400	2552
330	626	600	1112	870	1598	1140	2084	1410	2570
340	644	610	1130	880	1616	1150	2102	1420	2588
350	662	620	1148	890	1634	1160	2120	1430	2606
360	680	630	1166	900	1652	1170	2138	1440	2624

## Comparative Standard Hardness Tests

BRINELL		SCLEROSCOPE	ROCKWELL C
Dia. of Impression	Number		
4.79	156	..	0
4.76	158	..	1
4.74	160	..	2
4.71	162	..	3
4.67	165	..	4
4.63	168	..	5
4.59	171	..	6
4.56	174	..	7
4.52	177	28	8
4.48	180	29	9
4.45	183	29	10
4.41	186	29	11
4.37	190	29	12
4.34	193	30	13
4.30	197	30	14
4.25	201	30	15
4.21	206	31	16
4.17	210	32	17
4.12	215	32	18
4.08	220	33	19
4.03	225	33	20
3.99	230	34	21
3.95	235	35	22
3.90	241	36	23
3.86	247	36	24
3.81	253	37	25
3.77	259	38	26
3.73	265	39	27
3.68	272	40	28
3.64	279	41	29
3.59	286	42	30
3.55	294	43	31
3.51	301	44	32
3.46	309	45	33
3.42	318	46	34
3.37	327	47	35
3.32	337	48	36
3.27	347	50	37



# **Comparative Standard Hardness Tests** (Continued)

BRINELL		SCLEROSCOPE	ROCKWELL C
Dia. of Impression	Number		
3.23	357	51	38
3.18	367	52	39
3.14	377	53	40
3.10	387	54	41
3.06	398	56	42
3.02	408	57	43
2.98	419	58	44
2.95	430	59	45
2.91	442	61	46
2.88	453	62	47
2.84	464	63	48
2.80	476	65	49
2.77	488	66	50
2.74	500	67	51
2.71	512	69	52
2.68	524	70	53
2.65	536	71	54
2.62	548	73	55
2.59	561	74	56
2.56	574	76	57
2.53	587	77	58
2.50	600	78	59
2.47	613	80	60
2.45	627	81	61
...	...	82	62
...	...	84	63
...	...	..	64
...	...	..	65
...	...	..	66

## Millimeter Equivalents in Inches

Millimeters	Inches	Millimeters	Inches	Millimeters	Inches
.10	= .0039	29	= 1.1427	66	= 2.5984
.20	= .0079	30	= 1.1811	67	= 2.6378
.30	= .0118	31	= 1.2205	68	= 2.6772
.40	= .0157	32	= 1.2599	69	= 2.7165
.50	= .0197	33	= 1.2992	70	= 2.7559
.60	= .0236	34	= 1.3386	71	= 2.7953
.70	= .0276	35	= 1.3780	72	= 2.8346
.80	= .0315	36	= 1.4173	73	= 2.8740
.90	= .0354	37	= 1.4567	74	= 2.9134
1	= .0394	38	= 1.4961	75	= 2.9528
2	= .0787	39	= 1.5354	76	= 2.9921
3	= .1181	40	= 1.5748	77	= 3.0315
4	= .1575	41	= 1.6142	78	= 3.0709
5	= .1969	42	= 1.6536	79	= 3.1102
6	= .2362	43	= 1.6929	80	= 3.1496
7	= .2756	44	= 1.7323	81	= 3.1890
8	= .3150	45	= 1.7717	82	= 3.2283
9	= .3543	46	= 1.8810	83	= 3.2677
10	= .3937	47	= 1.8504	84	= 3.3071
11	= .4331	48	= 1.8988	85	= 3.3465
12	= .4724	49	= 1.9291	86	= 3.3858
13	= .5118	50	= 1.9685	87	= 3.4252
14	= .4412	51	= 2.0079	88	= 3.4646
15	= .5906	52	= 2.0472	89	= 3.5039
16	= .6299	53	= 2.0866	90	= 3.5433
17	= .6693	54	= 2.1260	91	= 3.5827
18	= .7087	55	= 2.1654	92	= 3.6221
19	= .7480	56	= 2.2047	93	= 3.6614
20	= .7874	57	= 2.2441	94	= 3.7008
21	= .8268	58	= 2.2835	95	= 3.7402
22	= .8661	59	= 2.3228	96	= 3.7795
23	= .9055	60	= 2.3622	97	= 3.8189
24	= .9449	61	= 2.4016	98	= 3.8583
25	= .9843	62	= 2.4409	99	= 3.8976
26	= 1.0236	63	= 2.4803	100	= 3.9370
27	= 1.0630	64	= 2.5197	...	= .....
28	= 1.1024	65	= 2.5591	...	= .....

# Areas of Square and Round Bars

Thickness or Diam. in Inches	Area of Square Bar in Sq. Inches	Area of Round Bar in Sq. Inches	Thickness or Diam. in Inches	Area of Square Bar in Sq. Inches	Area of Round Bar in Sq. Inches
$\frac{1}{8}$	.0039	.0031	$3\frac{1}{2}$	12.250	9.6211
$\frac{1}{8}$	.0156	.0123	$3\frac{5}{8}$	13.141	10.321
$\frac{1}{4}$	.0352	.0276	$3\frac{3}{4}$	14.063	11.045
$\frac{1}{4}$	.0625	.0491	$3\frac{7}{8}$	15.016	11.793
$\frac{1}{2}$	.0977	.0767	4	16.000	12.566
$\frac{3}{8}$	.1406	.1104	$4\frac{1}{8}$	17.016	13.364
$\frac{1}{2}$	.1914	.1503	$4\frac{1}{4}$	18.063	14.186
$\frac{3}{4}$	.2500	.1963	$4\frac{3}{8}$	19.141	15.033
$\frac{7}{8}$	.3164	.2485	$4\frac{1}{2}$	20.250	15.904
$\frac{5}{8}$	.3906	.3068	$4\frac{5}{8}$	21.391	16.800
$1\frac{1}{8}$	.4727	.3712	$4\frac{3}{4}$	22.563	17.721
$\frac{3}{4}$	.5625	.4418	$4\frac{7}{8}$	23.766	18.665
$1\frac{1}{8}$	.6602	.5185	5	25.000	19.635
$\frac{7}{8}$	.7656	.6013	$5\frac{1}{8}$	26.266	20.629
$1\frac{1}{8}$	.8789	.6903	$5\frac{1}{4}$	27.563	21.648
1	1.0000	.7854	$5\frac{3}{8}$	28.891	22.691
$1\frac{1}{8}$	1.1289	.8866	$5\frac{1}{2}$	30.250	23.758
$1\frac{1}{8}$	1.2656	.9940	$5\frac{5}{8}$	31.641	24.851
$1\frac{1}{4}$	1.4102	1.1075	$5\frac{3}{4}$	33.063	25.967
$1\frac{1}{4}$	1.5625	1.2272	$5\frac{7}{8}$	34.516	27.109
$1\frac{3}{8}$	1.7227	1.3530	6	36.000	28.274
$1\frac{3}{8}$	1.8906	1.4849	$6\frac{1}{8}$	37.516	29.465
$1\frac{1}{2}$	2.0664	1.6230	$6\frac{1}{4}$	39.063	30.680
$1\frac{1}{2}$	2.2500	1.7671	$6\frac{3}{8}$	40.641	31.919
$1\frac{1}{2}$	2.4414	1.9175	$6\frac{1}{2}$	42.250	33.183
$1\frac{5}{8}$	2.6406	2.0739	$6\frac{5}{8}$	43.891	34.472
$1\frac{1}{2}$	2.8477	2.2365	$6\frac{3}{4}$	45.563	35.785
$1\frac{3}{4}$	3.0625	2.4053	$6\frac{7}{8}$	47.266	37.122
$1\frac{3}{4}$	3.2852	2.5802	7	49.000	38.485
$1\frac{7}{8}$	3.5156	2.7612	$7\frac{1}{8}$	50.766	39.871
$1\frac{7}{8}$	3.7539	2.9483	$7\frac{1}{4}$	52.563	41.283
2	4.0000	3.1416	$7\frac{3}{8}$	54.391	42.718
$2\frac{1}{8}$	4.2539	3.3410	$7\frac{1}{2}$	56.250	44.179
$2\frac{1}{8}$	4.5156	3.5466	$7\frac{3}{4}$	60.063	47.173
$2\frac{1}{4}$	4.7852	3.7583	8	64.000	50.266
$2\frac{1}{4}$	5.0625	3.9761	$8\frac{1}{4}$	68.063	53.456
$2\frac{3}{8}$	5.3477	4.2000	$8\frac{1}{2}$	72.250	56.745
$2\frac{3}{8}$	5.6406	4.4301	$8\frac{3}{4}$	76.563	60.132
$2\frac{1}{2}$	5.9414	4.6664	9	81.000	63.617
$2\frac{1}{2}$	6.2500	4.9087	$9\frac{1}{4}$	85.563	67.201
$2\frac{5}{8}$	6.5664	5.1573	$9\frac{1}{2}$	90.250	70.882
$2\frac{5}{8}$	6.8906	5.4119	$9\frac{3}{4}$	95.063	74.662
$2\frac{3}{4}$	7.2227	5.6727	10	100.00	78.540
$2\frac{3}{4}$	7.5625	5.9396	$10\frac{1}{4}$	105.06	82.516
$2\frac{7}{8}$	7.9102	6.2126	$10\frac{1}{2}$	110.25	86.590
$2\frac{7}{8}$	8.2656	6.4918	$10\frac{3}{4}$	115.56	90.763
$2\frac{1}{2}$	8.6289	6.7771	11	121.00	95.033
3	9.0000	7.0686	$11\frac{1}{4}$	126.56	99.402
$3\frac{1}{8}$	9.7656	7.6699	$11\frac{1}{2}$	132.25	103.87
$3\frac{1}{4}$	10.563	8.2958	$11\frac{3}{4}$	138.06	108.43
$3\frac{3}{8}$	11.391	8.9462	12	144.00	113.09

# Fractions of an Inch in Equivalent Decimals

Fractions of an Inch		Decimals of an Inch	Fractions of an Inch		Decimals of an Inch
$\frac{1}{64}$	=	.015625	$\frac{33}{64}$	=	.515625
$\frac{3}{32}$	=	.03125	$\frac{1}{2}$	=	.53125
$\frac{3}{64}$	=	.046875	$\frac{35}{64}$	=	.546875
$\frac{1}{8}$	=	.0625	$\frac{7}{8}$	=	.5625
$\frac{5}{64}$	=	.078125	$\frac{37}{64}$	=	.578125
$\frac{3}{16}$	=	.09375	$\frac{39}{64}$	=	.59375
$\frac{7}{64}$	=	.109375	$\frac{39}{64}$	=	.609375
$\frac{1}{8}$	=	.125	$\frac{5}{8}$	=	.625
$\frac{9}{64}$	=	.140625	$\frac{41}{64}$	=	.640625
$\frac{5}{16}$	=	.15625	$\frac{3}{2}$	=	.65625
$\frac{11}{64}$	=	.171875	$\frac{43}{64}$	=	.671875
$\frac{3}{8}$	=	.1875	$\frac{11}{8}$	=	.6875
$\frac{13}{64}$	=	.203125	$\frac{45}{64}$	=	.703125
$\frac{7}{16}$	=	.21875	$\frac{3}{2}$	=	.71875
$\frac{15}{64}$	=	.234375	$\frac{47}{64}$	=	.734375
$\frac{1}{4}$	=	.250	$\frac{3}{4}$	=	.750
$\frac{17}{64}$	=	.265625	$\frac{49}{64}$	=	.765625
$\frac{3}{8}$	=	.28125	$\frac{3}{2}$	=	.78125
$\frac{19}{64}$	=	.296875	$\frac{51}{64}$	=	.796875
$\frac{1}{2}$	=	.3125	$\frac{1}{2}$	=	.8125
$\frac{21}{64}$	=	.328125	$\frac{53}{64}$	=	.828125
$\frac{1}{2}$	=	.34375	$\frac{3}{2}$	=	.84375
$\frac{23}{64}$	=	.359375	$\frac{55}{64}$	=	.859375
$\frac{3}{8}$	=	.375	$\frac{7}{8}$	=	.875
$\frac{25}{64}$	=	.390625	$\frac{57}{64}$	=	.890625
$\frac{1}{2}$	=	.40625	$\frac{3}{2}$	=	.90625
$\frac{27}{64}$	=	.421875	$\frac{59}{64}$	=	.921875
$\frac{1}{2}$	=	.4375	$\frac{1}{2}$	=	.9375
$\frac{29}{64}$	=	.453125	$\frac{61}{64}$	=	.953125
$\frac{1}{2}$	=	.46875	$\frac{3}{2}$	=	.96875
$\frac{31}{64}$	=	.484375	$\frac{63}{64}$	=	.984375
$\frac{1}{2}$	=	.500	1 in.	=	1.000

### THERMOMETER CONVERSION SCALE

In the United States and Canada the Fahrenheit temperature scale is in almost general use, and in this catalogue reference to degrees of temperature is to that scale.

However, since certain countries use the metric system, and many technical publications refer to degrees of temperature according to the Centigrade scale, the following rules for conversion will be found useful:

#### TO SECURE FAHRENHEIT READING:

Multiply the known Centigrade reading by nine-fifths ( $9/5$ ) and add 32.

#### TO SECURE CENTIGRADE READING:

Subtract 32 from the known Fahrenheit reading and multiply the remainder by five-ninths ( $5/9$ ).

### USEFUL RULES

To find the area of a circle, multiply the square of the diameter by .7854.

To find the area of a square, or of a rectangle, multiply the width by the thickness.

To find the area of an octagon, multiply the square of the diameter of the inscribed circle by .828.

To find the area of a regular hexagon, multiply the square of the diameter of the inscribed circle by .866.

To find the area of a triangle, multiply the width of the base by one-half of the perpendicular height.

To find the area of a trapezoid, multiply the sum of the parallel sides by the perpendicular distance between them, and divide the product by two (2).

The weight of one cubic foot of steel is approximately 490 pounds.

The weight of one cubic inch of steel is approximately .285 pound, but since steel is commercially supplied slightly "full" to dimensions specified, .3 may be used in calculating weights when the cubic inches in any piece or bar is known.

While this method does not supply accurate weight information, it nevertheless produces results which are sufficiently true for ordinary purposes.



## United States

### Branch Houses and Agencies

NEW YORK, N. Y.	Wm. Jessop & Sons, Inc.	91 John St.
BOSTON, Mass.	Wm. Jessop & Sons, Inc.	163 High St.
CHICAGO, Ill.	Wm. Jessop & Sons, Inc.	1857 Fulton St.
BALTIMORE, Md.	Wm. G. Wetherall	311-317 President St.
BRIDGEPORT, Conn.	Hunter & Havens	245 Water St.
BUFFALO, N. Y.	Beals, McCarthy & Rogers, Inc.	40 Terrace.
DERBY, Conn.	The F. Hallock Co.	116 Main St.
DETROIT, Mich.	Craine-Schrage Steel Co.	6189 Hamilton Ave.
HARTFORD, Conn.	L. L. Ensworth & Son, Inc.	340-350 Front St.
LOS ANGELES, Cal.	Southern Steel & Supply Co., Inc.	612 E. 12th St.
NEWARK, N. J.	James A. Coe & Co.	395 Washington St.
NEW HAVEN, Conn.	The C. S. Mersick & Co.	286 State St.
PHILADELPHIA, Pa.	E. L. Hand & Co.	521 Arch St.
PROVIDENCE, R. I.	Nightingale, Baker & Salisbury	180 W. Exchange St.
ROCHESTER, N. Y.	Homer Strong & Co.	285 State St.
ST. LOUIS, Mo.	Beck & Corbitt Co.	First St., from Ashley to O'Fallon.
SAN FRANCISCO, Cal.	S. F. Dicks	20-22 Natoma St.
SYRACUSE, N. Y.	Burhans & Black, Inc.	136 N. Salina St.
WATERBURY, Conn.	Chas. A. Templeton, Inc.	13 E. Main St.
WORCESTER, Mass.	Geo. F. Blake, Jr., & Co.	Junction of Bridge, Mechanic & Foster Sts.

## Canadian

### Branch House and Agencies

Toronto, Ont.	Wm. Jessop & Sons, Ltd.	230 Bay St.
Montreal, Que.	F. Bacon & Co., Ltd.	131 St. Paul St. W.
Vancouver, B. C.	McLennan, McFeely & Co., Ltd.	99 Cordova St. E.

## Foreign Depots

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